

FIELD OF THE INVENTION

BACKGROUND OF THE INVENTION

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digital subscriber line access multiplexers (DSLAMs) and voice gateways in the signal transport path from a central office to a customer premises-resident IAD.

Since the IAD is customer-purchased and installed,
5 the service provider does not participate in the customer's choice of what is connected to the DSL line. However, in order for the customer to be able to conduct (packetized) voice over digital subscriber line (vodsl) communications through its IAD, it is necessary that the
10 IAD's supervisory communications controller be properly initialized or preconfigured with a prescribed set of communication parameters that make the IAD compatible with the DSLAM and voice gateway equipment, that may be sourced from a variety of vendors, each having their own
15 proprietary methods for handling various layer services, set-up and management.

Now although this and other parameter information of the subscription service are provided by the service provider to the purchaser of the terminal equipment, the
20 customer is usually technically unsophisticated and accustomed to doing nothing more than performing a 'plug-and-play' exercise. Indeed, experience has revealed that a very large majority of DSL customers will burden the equipment supplier and/or the service provider with
25 requests for technical support in the course of configuring the IAD, irrespective of whether the service provider has correctly supplied each of the parameters to the customer.

SUMMARY OF THE INVENTION

In accordance with the present invention, the user's (actual or perceived) inability to properly configure an IAD, even when provided with correctly assigned operational parameters by the service provider, is successfully remedied by an automated IAD configuration mechanism, that is resident in the control software employed by the communications controller of the customer premises-installed IAD. As will be described, this automated IAD mechanism is operative to perform an analysis of the digital communications link to which the IAD is connected, and thereby identify communication interface equipment, such as DSLAM and voice gateway units, employed by the service provider. It then automatically configures communication parameters of the IAD for communication compatibility with the identified (DSLAM and voice gateway) devices.

The automated link analysis mechanism initially performs a first automated communication property analysis of the communications link to determine the digital transport encoding format, such as high level data link control (HDLC) protocol, asynchronous transfer mode (ATM) protocol, or customized ATM protocol. This initial analysis includes determining line rate, and digital transport encoding format in accordance with information representative of the line rate. Then, using information representative of the digital transport encoding format, it performs a second automated

communication property analysis to identify a communication interface device such as a DSLAM. Once the DSLAM is identified, a communication property analysis of the communications link is performed to identify the voice gateway, and its voice transport protocol. Also, parameters associated with the voice gateway are determined, such as virtual circuit address, number of voice ports, and port signaling.

BRIEF DESCRIPTION OF THE DRAWINGS

10 Figure 1 diagrammatically illustrates a reduced complexity example of a digital telecommunication network, having a link coupled from a telephone company (telco) central office to customer premises equipment containing the present invention;

15 Figure 2 is a high level flow chart of the automated IAD configuration process of the present invention;

Figure 3 is a flow chart of a layer 1 subroutine employed within the automated IAD configuration process of Figure 2;

20 Figure 4 is a flow chart of a layer 2 subroutine employed within the automated IAD configuration process of Figure 2; and

Figure 5 is a flow chart of a layer 3 subroutine employed within the automated IAD configuration process of Figure 2.

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DETAILED DESCRIPTION

Before describing in detail the automated IAD configuration mechanism in accordance with the present invention, it should be observed that the invention
5 resides primarily in what is effectively a prescribed DSL communication link pre-establishment control mechanism, that is embedded in the communications control software resident in the packet communications controller of an integrated access device. Consequently, the invention has
10 been illustrated in the drawings in block diagram and associated flow chart format, which show only those specific details that are pertinent to the present invention, so as not to obscure the disclosure with details which will be readily apparent to those skilled
15 in the art having the benefit of the description herein. Thus, the block diagram and flow chart illustrations are primarily intended to illustrate the major components of the IAD configuration mechanism of the invention in a convenient functional grouping, whereby the present
20 invention may be more readily understood.

Figure 1 is a reduced complexity diagrammatically illustration of the interconnection of customer premises installed DSL connectivity device, here an integrated access device (IAD) 10, serving multiple customer
25 premises equipments (CPEs) 11, via a digital communication link 12 (such as a T1 link, as a non-limiting example) to a central office 14 of a communication service provider, through which access to

10 a public switched telephone network (PSTN) packet data network is provided. As a non-limiting example, the IAD 10 may comprise an Total Access 608 IAD, manufactured by Adtran Corp., Huntsville, Alabama. It should be observed, 5 however, that the invention is not limited to use with this or any other particular type of integrated access device, but is intended as an augmentation to the communication supervisory control mechanisms employed in IADs supplied from a variety of communication equipment 10 manufacturers.

As pointed out briefly above, various configuration parameters required for successful operation of the integrated access device are usually supplied by the service provider. However, being technically 15 inexperienced, the customer may have difficulty in setting up such configuration parameters and can be expected to call the equipment supplier and/or the local telephone service provider, with a request for assistance as to how to configure the IAD.

20 In accordance with the invention, this problem is successfully obviated by augmenting the control software employed by the IAD's supervisory communications controller 15, to which the DSL link 12 from the central office is coupled, to include an automated IAD 25 configuration mechanism. This automated IAD configuration mechanism is operative to execute a prescribed analysis in the negotiation and configuration of the IAD, as shown in the multi-layer sequence of the flow chart of Figure

2. Based upon this analysis, the invention is able to automatically configure (set the operational parameters of) the customer's IAD to conform with those of communication interface devices (voice gateway and DSLAM equipments) employed by the service provider.

As shown in Figure 2, the automated IAD configuration process of the present invention is comprised of a sequence of layers: LAYER 1, LAYER 2, LAYER 3, and LAYER 4, the successful completion of each of which is required before moving to the next layer; any failure to resolve a layer reverts the routine to the beginning of the sequence. As will be described with reference to the detailed flow diagram of Figure 3, layers 1 and 2 are interrelated, such that layer 2 information can be used to assist in identifying layer 1 configuration options.

Layer 1, shown at step 201, serves to train up the DSL link and determine whether the link is using high level data link control (HDLC), ATM, or a customized (framed) ATM transport protocol. Layer 1 identification is subject to vendor-specific implementations of the layer 1 interface controller and configuration of those options by the remote device.

In order to provide an instructive, but non-limiting example, the following description of conducting a layer 1 determination will assume that an SDSL interface of the type available from Conextant Systems, Inc., Newport Beach, Cal., is employed. This choice of SDSL interface

proceeds to scan all possible line rates. If the line rate is determined in step 302, (the result of step 302 is a SUCCESS), the sub-routine transitions to step 304. If no line rate is found in either of steps 301 or 302
5 (the result of step 302 is a FAILURE), it is inferred that the line rate cannot be determined, as denoted by the state "Automatic Configuration failed" 303, and the routine reverts back to the start of the auto-configuration sequence of Figure 2.

10 To determine layer 1 encoding, step 304 examines a priori known operating modes and selectable options for the layer 1 interface device, as described above. If layer 1 encoding cannot be determined (the result of step 304 is FAILURE), it is inferred that layer 1 cannot be
15 completely determined. The routine therefore transitions to the "Automatic Configuration failed" state 303, and reverts back to the start of the auto-configuration sequence of Figure 2, as described above. Layer 2, shown at step 202 in the flow chart of Figure 2, serves to
20 determine which type of DSLAM format is employed, and thus involves the format of the data prior to the layer 1 device encoding and subsequent to layer 1 device decoding.

For this purpose, as shown in the layer 2 subroutine
25 of Figure 4, the data stream is examined in step 401 for the presence of pre-layer 1 encoding/decoding framers, known a priori from vendor-supplied information stored in memory. The pre-layer 1 encoding/decoding framers provide

data stream synchronization. If the framer cannot be determined (the result of step 401 is a FAILURE), the layer 2 subroutine reverts to the start of the auto-configuration sequence of Figure 2, as described above.

5 However, if the framer is determined (the result of step 401 is a SUCCESS), the layer 2 subroutine transitions to step 402, to identify the payload specific protocol. Payload protocols provide a variety of operating features, including routing information, control and management information, delivery of end-user data, etc. If the payload specific protocol cannot be determined (the result of step 402 is a FAILURE), the layer 2 subroutine reverts to the start of the auto-configuration sequence of Figure 2, as described above.

15 If the payload specific protocol is determined (the result of step 402 is a SUCCESS), the layer 2 subroutine proceeds to query step 403 to determine if the type of line is ATM. If the answer to query step 403 is YES (indicating an ATM line), the subroutine transitions to step 404, which identifies ATM line parameters, data scrambling and idle cell type. Otherwise, the routine reverts to layer 1. To identify whether data scrambling has been enabled or disabled, both modes are attempted, step 404 looks for cell delineation.

25 To determine whether the cell type is idle or unassigned, step 404 may initially assume a given cell type and then observe unknown permanent virtual circuit (PVC) discards. If there is a high rate of unknown PVC

discards, it is inferred that the wrong cell type had been initially assumed, and the other cell type is selected. Once layer 2 determination has been successfully completed, the routine transitions to the
5 layer 3 determination, shown at step 203 in the flow chart of Figure 2, and in the detailed subroutine of Figure 5.

Layer 3 serves to locate the voice gateway. At an initial query step 501, the subroutine looks for the
10 presence of a standards message based protocol for determining voice gateway and parameters. If the answer to step 501 is YES/SUCCESS, the subroutine transitions to step 502, wherein the detected standards message based protocol is used to configure the voice gateway.
15 Otherwise (the answer to step 501 is NO), an iterative procedure beginning at step 503 is used. It is possible that a detected message based protocol will not detect all necessary parameters. In this event, the located parameters are stored in step 501 and the routine
20 transitions to step 503 of the iterative procedure to detect the remaining parameters.

The information to be determined includes a variety of parameters, such as, but not limited to: virtual circuit address, voice gateway type, number of voice
25 ports, port compression, and port signaling. There are currently available in-band methods for determining a small subset of some these parameters, that are applicable to the particular voice gateway type. In these

cases, once the voice gateway type is known, such an in-band method will be initially employed. As an example, a voice gateway provided by Jetstream Corp. has provisions for setting the port signaling parameter for each port of
5 an IAD.

At step 503, the result of the DSLAM detection phase of layer 2 is identified. The virtual circuit (VC) address is selected in step 504, and the signaling state may be used to confirm the virtual circuit address. If
10 Frame Relay has been selected, the VC address is the data link connection identifier (DLCI) 22. If ATM has been detected, the virtual circuit address is selected as VPI:VCI 0:39. The presence of a virtual circuit address (but not whether it supports voice) may be confirmed by
15 using OAM loopback cells.

Once the virtual circuit address has been selected, the routine transitions to step 505, to locate the voice gateway type. In step 505, virtual circuit addresses are individually identified, and the associated voice gate
20 type is then attempted. As a non-limiting example, the sequence of protocols for the voice gateway types may include Jetstream, CopperCom., TollBridge, MGCP, Megaco, LES-CCS (ATM Forum Loop Emulation Service-Common Channel Signaling), and LES-CAS (ATM Forum Loop Emulation
25 Service-Channel Associated Signaling).

Some types of voice gateways, such as Jetstream and LES-CCS, may support multiple voice gateway protocols. In step 505, Jetstream and LES-CCS protocols may be detected

by their use of different but specific sub-channel
identifiers for call control messages. Most gateway
protocols require the initial message to be sent by the
IAD; thus, the subroutine may send an initial message and
5 then wait for a specific timeout for a response. For
CopperCom and LES-CAS protocols, it is necessary to
attempt a temporary call on one port, to determine if a
voice gateway is present. More recent versions of the
CopperCom gateway support an in-band EOC channel, which
10 can be used instead for detection and configuration.

The number of voice ports can be detected either
through the specific in-band management channel, or by
transitioning through the range of voice ports attempting
a call and looking for a response stream of messages. If
15 there is a failure of any of the steps of voice gateway
locate subroutine, the IAD configuration routine fails
and reverts to step 201 of Figure 2.

Once the parameters required of the IAD have been
negotiated in layers 1, 2 and 3, the routine transitions
20 to step 204, wherein layer 4 of the supervisory control
program executed by the IAD's microcontroller proceeds to
configure one or more special features to increase
throughput or enhance performance. If the microcontroller
is able to complete the configuration of the IAD for the
25 identified DSLAM and gateway parameters, the routine is
complete; otherwise, the routine fails and reverts to
step 201 of Figure 2.

As will be appreciated from the foregoing description, the present invention effectively circumvents the inability of a DSL equipment user to properly configure an installed IAD, irrespective of whether or not the customer has been provided with correctly assigned configuration parameters by the service provider. Because it is embedded within the control software employed by the communications controller of the customer premises-installed IAD, the invention is effectively transparent to the user. When the IAD is placed in service, its communications controller first performs the autoconfiguration procedure hereindescribed. Through this procedure, both and voice gateway units employed by the service provider are identified. Thereafter the autoconfiguration routine automatically configures communication parameters of the IAD for communication compatibility with the identified DSLAM and voice gateway units.

While we have shown and described an embodiment in accordance with the present invention, it is to be understood that the same is not limited thereto but is susceptible to numerous changes and modifications as known to a person skilled in the art, and we therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are obvious to one of ordinary skill in the art.